Microdrone With Proximity Alert Using Lidar

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Abstract-The rapid advancement of unmanned aerial vehicles (UAVs) has opened up new possibilities for compact and efficient drones capable of autonomous navigation in complex environments. This paper presents the design and development of a microdrone equipped with a proximity alert system using LiDAR technology. The primary objective is to enhance obstacle detection and collision avoidance capabilities in real-time, enabling safer and smarter drone operation, especially in constrained or cluttered environments.The microdrone is built using a lightweight frame, drone motors, and a flight controller integrated with a NodeMCU microcontroller for control and communication. A LiDAR sensor is employed to continuously measure distances from surrounding objects with high accuracy. The proximity alert system is triggered when obstacles are detected within a predefined range, activating a buzzer and enabling the drone to take evasive action or hover to avoid collision. This system demonstrates the effective use of LiDAR for short-range obstacle detection and its potential in enhancing drone autonomy. Applications include indoor navigation, search and rescue missions, inspection tasks, and delivery in urban environments where precision and safety are critical.

I. INTRODUCTION

Microdrones, also known as mini or nano drones, are gaining popularity due to their compact size, agility, and ability to operate in confined spaces [2]. Their applications span various domains including surveillance, environmental monitoring, delivery systems, and disaster response. However, safe navigation remains a key challenge, especially in environments filled with obstacles. To address this, integrating advanced sensing technologies becomes crucial [5].

LiDAR (Light Detection and Ranging) is a powerful sensor technology that uses laser pulses to measure distances with high precision [1]. It creates accurate 3D maps of the environment, making it an ideal choice for obstacle detection and avoidance in UAVs [3] Compared to ultrasonic or infrared sensors, LiDAR provides better range, accuracy, and reliability under different lighting conditions [2].

This paper focuses on developing a microdrone equipped with a LiDAR-based proximity alert system [6]. The drone uses the LiDAR sensor to detect nearby obstacles and triggers a buzzer alert when objects are within a critical distance. The NodeMCU microcontroller processes LiDAR data and communicates with the flight controller to ensure responsive and safe navigation [4].

By incorporating LiDAR, this paper aims to enhance the operational safety and autonomy of microdrones, enabling them to perform better in both indoor and outdoor environments where precise obstacle detection is essential

II. SYSTEM ARCHITECTURE

The proposed system is designed to enhance the safety by incorporating obstacle-awareness capability to microdrone using a LiDAR-based proximity alert mechanism. The main objective of this system is to detect obstacles in the drone's flight path and generate an alert when the drone approaches any object within a predefined unsafe range. This is particularly useful in applications such as indoor navigation, search and rescue operations, or autonomous surveillance where obstacle avoidance is critical.

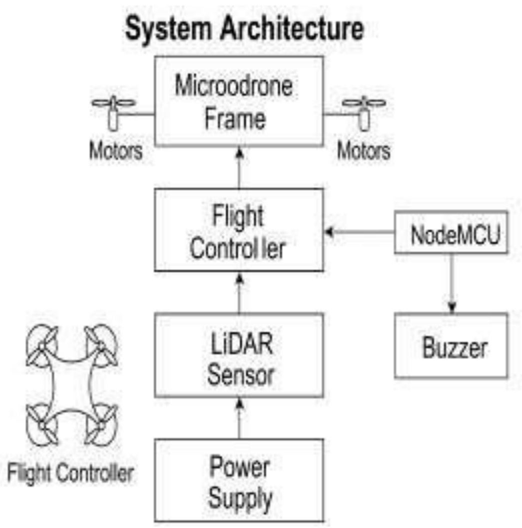

Fig.1: System block diagram

1. Microdrone Frame & Motors: The microdrone is a quadcopter equipped with 4 brushless DC motors for lift and maneuverability. Propellers are attached to the motors, and the motor speeds are controlled through Electronic Speed

Controllers (ESCs).The frame is lightweight to support flight with the payload (LiDAR, buzzer, NodeMCU).

2. Flight Controller: Acts as the brain of the drone's flight system. It stabilizes the drone using data from onboard gyroscope and accelerometer sensors. Takes input from the remote controller (if manually operated) and generates PWM signals to control ESCs and motors. Ensures smooth flight even when extra components (like sensors) are added.

3. NodeMCU (ESP8266): It is used to process LiDAR data and control the alert system. It receives distance data from the LiDAR sensor in real-time using UART/I2C.If the distance is less than a preset safety threshold (e.g., 50 cm), it activates the buzzer. Acts independently of the flight controller, so the drone's flight isn't interrupted.

4. LiDAR Sensor: LiDAR (Light Detection and Ranging) sensor emits laser pulses to measure the distance of nearby objects. In our paper, a sensor like TF-Luna or TF-mini is typically used. Provides high-accuracy distance measurements with fast refresh rates, which is essential for real-time obstacle detection. Mounted at the front or bottom of the drone depending on where obstacle detection is required.

5. Buzzer (Alert Unit): A simple piezo buzzer acts as an audio alert when an object is too close. Triggered by the NodeMCU when obstacle distance drops below the set threshold. It can be replaced or extended with LED indicators, vibration motors, or wireless alerts in future enhancements.

6. Power Supply Unit: A rechargeable Li-Po battery (typically 11.1V or 7.4V) powers the drone, including its flight controller and motors. A 5V voltage regulator is used to power the NodeMCU and LiDAR sensor. Efficient power distribution ensures stable operation of all modules.

Data Flow Summary:

1. The LiDAR sensor continuously scans the surroundings and measures the distance to nearby obstacles using Time-of-Flight laser pulses.
2. Distance data from the LiDAR sensor is transmitted to the NodeMCU microcontroller via UART or I2C communication.
3. The NodeMCU processes the incoming distance values and compares them with a predefined safety threshold (e.g., 50 cm).
4. If the detected distance is below the threshold, the NodeMCU immediately activates the buzzer to alert the user of a potential collision.
5. If the distance is safe, the buzzer remains inactive and the drone continues normal flight operations.
6. The flight controller simultaneously handles drone stabilization and movement, operating independently from the proximity alert system.
7. This entire sensing–decision–alert cycle repeats in real time, ensuring continuous monitoring and immediate response to obstacles during flight.

III. IMPLEMENTATION:

Flow Chart:

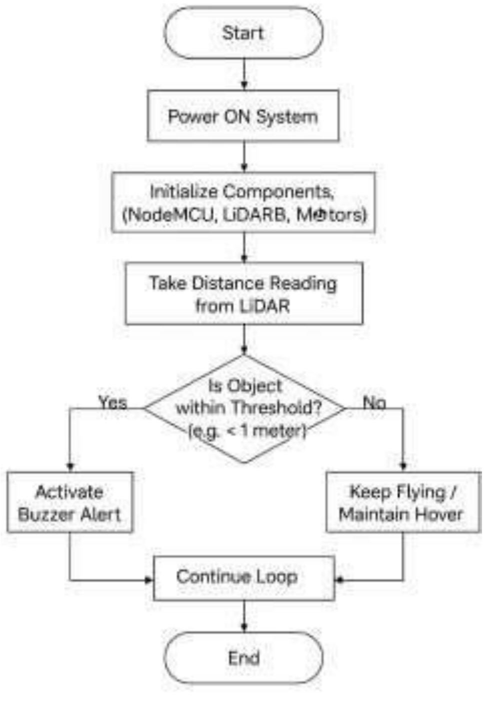

Fig. 2: Flow chart of Microdrone with Proximity Alert using LiDAR

1. Start: The drone system is initiated (can be triggered manually or automatically).
2. Power ON System: Power is supplied to all electronic components (battery connection).
3. Initialize Components: The microcontroller (NodeMCU), LiDAR sensor, and motors are initialized and made ready for operation.
4. Take Distance Reading from LiDAR: The LiDAR sensor starts scanning the surroundings and measures the distance to nearby objects.
5. Check: Is Object within Threshold? (e.g., < 1 meter):
   - The system checks if any obstacle is closer than the predefined safe distance.
   - This is a decision-making point (Yes/No condition).
6. If 'Yes' (Obstacle Detected within Threshold):
   The buzzer alert is activated to signal a nearby obstacle.
7. If 'No' (No Obstacle within Range): The drone continues flying normally or maintains its hover position.

8. Continue Loop: The system keeps looping through distance measurements to continuously monitor surroundings in real-time.
9. End (Optional): This flow can end when the drone is powered off or operation is manually stopped.

The Table 1 provides the specifications of the components used in the implementation.

Table 1: Component and Specifications

Component	Specification	Unit
Lidar Sensor	Max Range: 12m, Accuracy:12cm	M, cm
NodeMCU	ESP8266, 3.3V Logic	V
Buzzer	5v DC	V
Drone motors	Brushless, 2300 RPM	V
Battery	7.4v Lipo, 2200mAh	V, mAh

This table is aims of three instructions:
1. Component selection: Identifies what hardware is used and what specs are needed.
2. Power planning: Helps ensure compatibility of voltage levels.
3. System design and integration: Ensures all components can work together efficiently for the drone's proximity alert function.

This table lists the key hardware components used in the microdrone and their technical specifications. It includes parts like the LiDAR sensor, NodeMCU microcontroller, motors, buzzer, and battery. These specifications are important for understanding the power requirements, communication compatibility, and performance limits of each component. For instance, the LiDAR's range and accuracy help determine how well it can detect obstacles, while the motor KV rating influences the drone's speed and thrust.

IV. RESULTS AND DISCUSSION

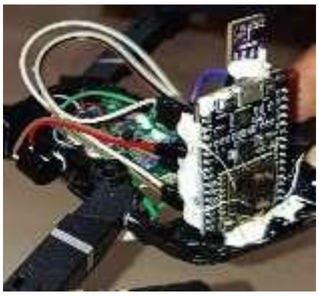

Fig 3: Interfacing of Buzzer with NodeMCU

Fig 4: Interfacing of Flight Controller with NodeMCU and LIDAR sensor with NodeMCU

Fig 5: Joystick used in operation

Fig 6: Resulted Drone

Table 2: Sample Distance Reading

Test #	Measured Distance (CM)	Buzzer Status
1	120	OFF
2	75	OFF
3	45	ON
4	30	ON

This Table 2 shows real-time data collected from the LiDAR sensor during testing. It logs the measured distance to nearby objects and whether the buzzer (proximity alert) was triggered. It helps demonstrate the functionality of the system, when an object is closer than the threshold (e.g., 50 cm), the alert system activates. This kind of data is useful for validating the effectiveness of the proximity detection and making adjustments if needed.

V. CONCLUSION

The development of the Microdrone with Proximity Alert using LiDAR demonstrates the practical integration of compact unmanned aerial systems with advanced sensing technologies for obstacle detection and navigation. By employing a LiDAR sensor, the microdrone effectively detects nearby objects and generates timely alerts using a buzzer, thereby enhancing flight safety in constrained or obstacle-rich environments.

This paper validates the potential of LiDAR in real-time proximity sensing, offering high accuracy and responsiveness compared to traditional sensors like ultrasonic or IR. The use of NodeMCU for processing and control adds flexibility and scalability for further applications such as autonomous navigation, indoor and mapping, or swarm-based coordination.

Overall, the paper successfully showcases a low-cost, efficient solution for collision avoidance, making it a valuable contribution toward safer and smarter microdrone operations.

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